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Commercial Fertilizers

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SUMMARY

The Oregon Fertilizer Control Law administered by the Agricultural Chemistry department of the Oregon Agricultural Experiment Station protects purchasers of commercial fertilizers against misrepresentation of the plant-food content by manufacturers.

The agricultural or crop-producing value of a fertilizer and the commercial value or selling price have no true relation. A discussion is given that distinguishes between the two terms.

The purchase of a commercial fertilizer is essentially the purchase of the plant foods, nitrogen, phosphorus, and potassium. The manner in which the plant foods are combined in commercial fertilizers is described.

The consumer is advised to purchase the high-grade fertilizers; i. e., fertilizers having a total plant-food content of 15 percent or above.

A method is given whereby the approximate cost of a fertilizer may be estimated. Comparisons may then be made of the commercial value of the various brands produced by different manufacturers.

A table is given showing the guaranteed and the found composition of all fertilizers sold in Oregon during 1922.

Brief reference is made to the State Lime Law, and a table is given showing the different brands of gypsum and limestone sold in the state during 1922.

Commercial Fertilizers

In the purchase of no other commodity offered on the market today is the consumer more liable to fraud than he is in the buying of fertilizers. As a protection, therefore, to both the consumer and the honest manufacturer, a law was passed governing the sale of commercial fertilizers in Oregon.

The Oregon State Fertilizer Law enacted in 1906 provides for the official registering and correct labeling of all fertilizers prior to their sale in the state. In December of each year manufacturers are required to submit to the Agricultural Chemistry department of the Oregon Agricultural Experiment Station a certificate of registration for each brand of fertilizer that will be sold by them during the ensuing year. This certificate is a guarantee statement showing the percentage and source of plant food which the fertilizer contains. Subsequently, when any amount of fertilizer is offered for sale each brand must be labeled in a manner to show its guaranteed composition. If a new brand is placed upon the market at any time during the year the manufacturer or agent must first file a similar certificate, declaring the composition of the fertilizer, before it is sold or offered for sale.

In order that the consumer may be protected from the unscrupulous manufacturer or agent, the Agricultural Chemistry department endeavors to collect and analyze annually at least one sample of every brand sold in the state. The manufacturers of those brands that are found to be below the guarantee as certified on the label or tag are notified and requested to make necessary correction. In the event that the composition of the fertilizer is not made to conform with the guarantee, consumers, county agents, and others interested are advised of the circumstances in order that they may avoid the use of those brands that do not come up to specifications. The fertilizer law then provides that court proceedings be taken against the manufacturer. Thus far no drastic action has been found necessary, although in several cases the manufacturers have been required to remix their material to bring ingredients up to the guaranteed composition.

The amount of commercial fertilizer used annually in Oregon is small in comparison with the amounts used in the states of the Middle West and the East. This fact is probably due to the prevailing belief that commercial fertilizers are as yet unnecessary in this state, and because their agricultural value from an economic standpoint has not been sufficiently recognized. Owing perhaps to more intensified and more specialized farming, however, opinion is gradually changing, and each year we note a greater increase in the quantity of commercial fertilizer used.

The importance of maintaining soil fertility by replacing those elements removed from the soil by similar elements or plant foods found in manure or commercial fertilizers cannot be overemphasized. Since on most farms the amount of manure available is not sufficient to maintain the fertility of the soil, it is frequently necessary to employ a commercial fertilizer. The number of soil constituents or plant foods liable to rapid exhaustion by the annual removal of crops is limited in most cases to five elements; namely, nitrogen, phosphorus, potassium, sulfur,

and calcium. The more common terminology for these plant foods is nitrogen, phosphoric acid, potash, sulfur, and lime, respectively. Each year the growing crop takes from the soil hundreds of pounds of these elements, and it is obvious that ultimately the quantity contained in the soil will become so low as to make profitable cropping impossible.

At present the Oregon Agricultural Experiment Station, in cooperation with the United States Department of Agriculture, is making a soil survey of the state which includes the location of the different soil types and chemical and physical analyses of the main types. A limited study will also be made of the beneficial results that may be obtained by the application of certain fertilizers on these types. The progress of the soil survey, however, will necessarily be slow, and meanwhile if fertilizers are to be used intelligently, numerous trial experiments on a small scale will have to be conducted by the consumer to determine local needs. It would be advisable for each farmer to make trial applications on a small area, using the different fertilizers suggested by fertilizer agents, experiment station specialists, county agricultural agents, and others, in order to ascertain what plant food or combination of plant foods will prove best and most profitable. It is generally conceded that the fertilizer to be used on any soil depends somewhat upon the previous crop raised, the amount of manure that has been applied in the past, the soil type, and the crop to be grown. Suggestions concerning the fertilizer that should be used on a particular soil may be obtained by writing to the Oregon Agricultural Experiment Station, giving full information regarding the location, soil type, crop grown in the past, the crop to be grown, and other data that may be deemed advisable. It may be said, in general, that on a particular soil a grower is warranted in using any fertilizer that yields additional crop values equal to or above the actual cost of the fertilizer applied. In some cases, especially for the growing of certain truck crops, it may be found profitable to fertilize lands that are judged rich. The greatest success attending the use of commercial fertilizers depends probably upon the individual farmer's wisdom or good judgment in observing the ordinary rules necessary for good farming.

AGRICULTURAL VALUE VERSUS COMMERCIAL VALUE

The agricultural value of a fertilizer depends upon its crop-producing power. The commercial value of a fertilizer is its price, its cost per ton on the market. The commercial valuation of a certain fertilizer does not therefore have any relation to its agricultural or crop-producing value on a given farm or soil. On account of the scarcity of a certain fertilizer, as is exemplified by the condition that prevailed during the war regarding potash, the market price may be abnormally high during one or more seasons. The crop-producing or agricultural value, however, is not subject to such fluctuations. Furthermore, the agricultural value of a certain fertilizer on one particular soil may be high as indicated by a large increase in crop production of the fertilized plot over the unfertilized plot, while the cost per ton of that particular fertilizer may be comparatively low. This same fertilizer, on the other hand, may not give any increase in crop production when applied to another soil type in the same or in a different locality where a different crop is grown. Thus is seen the importance of first ascertaining the actual agricultural value or crop-producing power of a fertilizer before investing heavily

in it. Judging from the crop to be grown, the type of soil, etc., we might conclude that a certain fertilizer would give good results; but in order absolutely to determine this point it would be necessary to make an actual application of it to the soil and observe its effect upon the crop. As previously stated, a few trials on small experimental plots, fertilized and unfertilized and growing the same crop, will be found most economical.

FERTILIZER INGREDIENTS

In order that fertilizers may be more intelligently used, and that a wiser choice may be exercised in the purchase of commercial brands, a definite knowledge of their composition and source is necessary. We shall have occasion to use frequently the terms "mixed" or "complete" fertilizers, "simples," "available" and "unavailable" plant foods, and it is desirable that we define them in order that the subject-matter discussed may be more easily understood.

Simples. For the sake of convenience and in order to distinguish between the materials used in "mixed" fertilizers and the mixed fertilizers themselves we called the former "simples." Simples are usually definite substances that are either by-products of some industry or prepared specifically for the one or more plant foods that they may contain. For example, tankage, bone-meal, and the like are by-products of the packing-house; nitrate of soda and superphosphates are prepared for the one plant food each contains, nitrogen and phosphorus, respectively. At present the following simples are used in Oregon: superphosphate, nitrate of soda, muriate of potash, blood-meal or dried blood, sulfate of ammonia, fish-meal, tankage, bone-meal, and dried manures or guanos.

Mixed or Complete Fertilizers. The mixed or complete fertilizer is composed of a combination of simples in a proportion to give a certain amount of nitrogen, phosphoric acid, and potash. The mixed fertilizers are sold in this state under specific names or brands. These brands are so compounded by the manufacturer that they contain those plant foods in proportions suitable for certain crops and soils. We consequently may have a mixed fertilizer containing, for example, a high percentage of phosphoric acid, a medium percentage of nitrogen, and a medium percentage of potash; or another, having a high percentage of nitrogen, a high percentage of phosphoric acid, and little or no potash.

Available Plant Foods. A plant food or element is considered "available" when it is in such form or combination that plants can immediately utilize it, or when it is in such form that, though not suited for immediate use, it gradually changes into the available condition during the growing season in which it is applied.

Unavailable Plant Foods. A plant food or element is "unavailable" when it is in such form or combination that plants cannot utilize it under any natural conditions, or when it becomes available so slowly under favorable conditions, as not to furnish, during a single growing season, appreciable amounts of material that can be used by the growing crops.

The following description of the various plant foods and of the fertilizer materials that contain these elements will give a more definite knowledge regarding the composition and ingredients of various commercial fertilizers. All statements regarding the source of materials and

the specific kinds of fertilizers mixed to form complete fertilizers apply to conditions that exist at present in Oregon.

Nitrogen. Nitrogen is probably the most commonly used and also the most expensive constituent of fertilizers. It may exist in the organic state, like the nitrogen of dried blood, or it may exist in the inorganic state, like the nitrogen of nitrate of soda. Other simples that contain nitrogen combined in the organic form are tankage, bone-meal, fish-meal, and the manures or guanos. Blood-meal is the most concentrated of the organic, nitrogen-containing simples. A high-grade product should contain at least 14 percent nitrogen. The nitrogen content of the other organic materials varies greatly; the exact amount present may be ascertained by referring to Table II showing the chemical composition of brands sold in Oregon. The nitrogen combined in the inorganic forms as nitrate of soda and sulfate of ammonia, should be present in quantities of about 15 and 20 percent respectively. Both of these forms, we note, have a very high percentage of nitrogen. The inorganic nitrogen of fertilizers is immediately available for plants, while the organic form is rapidly changed to the available condition when applied to the soil. Before assimilation by the plants, the nitrogen must be in a soluble state. Nitrate of soda and sulfate of ammonia are readily soluble, while organic nitrogen when worked into the soil is quickly changed by chemical and bacterial action to the soluble or nitrate form. The relative agricultural values of the organic and the inorganic forms depend largely upon the nature of the soil. If the soil is low in humus and organic compounds the organic nitrogen will probably be preferable and more profitable; while on the other hand if there is sufficient or an abundance of organic matter present, the inorganic form will no doubt give as good or even better returns. The form in which nitrogen exists in a mixed fertilizer may be ascertained from the agent or manufacturer. This information may also be obtained by writing to the Agricultural Chemistry department of the Oregon Agricultural Experiment Station.

Potash. All the potash guaranteed to be present in the commercial fertilizers sold in this state is in a soluble form and readily available to plants immediately after working well into the soil. It is represented by the formula K_2O. The minimum amount actually present in a fertilizer is given on the label, so that no difficulty should be experienced in judging the commercial value of any fertilizer from that standpoint. The simples used as a source of potash in mixed fertilizers are muriate of potash, sulfate of potash, and sheep guano.

Phosphoric Acid. The designation of this constituent of commercial fertilizers is perhaps somewhat confusing. It may be asked, What is meant by phosphoric acid in fertilizers? It does not mean that fertilizers contain free phosphoric acid. The term phosphoric acid used with reference to fertilizers is merely a convenient designation of the amount of phosphorus present in a fertilizer. Chemists express the amount of the element phosphorus present in a fertilizer by the formula P_2O_5, and refer to it as phosphoric acid.

Since the phosphorus of fertilizers is chemically combined in various ways, it is necessary to make a distinction between that part which may be used as plant food and the remainder that is so combined that it cannot be easily utilized.

Available phosphoric acid means the amount of phosphoric acid that is in a condition for immediate use by the plant during the growing season. The larger part of the available phosphoric acid is soluble in water and is therefore called "soluble" or "water soluble" phosphoric acid. The remainder, which is usually the smaller portion of the available phosphoric acid is not soluble in water but is soluble in a solution of neutral ammonium citrate of a certain strength. This solution will dissolve all the phosphoric acid that is chemically combined in such a way that the plant can use it during the growing season, but it will not dissolve any that the plant cannot use. This smaller portion is often referred to as "reverted" phosphoric acid, or "citrate-soluble" phosphoric acid, because the water-soluble form when applied to the soil reverts to this condition. Experience has shown that this citrate-soluble or reverted phosphoric acid is readily used by the plants during the growing season. Hence the sum of the water-soluble phosphoric acid and the citrate-soluble phosphoric gives the available phosphoric acid.

Insoluble or unavailable phosphoric acid is that portion of the phosphorus content of fertilizers that is not soluble in water or neutral ammonium citrate. This portion is only very slowly changed to a condition that may be taken up by the plants and is therefore of small value.

The following simples are phosphorus-containing fertilizers: superphosphate, tankage, bone-meal, fish-meal, and the manures.

Superphosphate or Acid Phosphate. Superphosphate or acid phosphate is prepared from an insoluble phosphate by treatment with sulfuric acid, which changes it into a soluble form, or by the pyrolytic method where mixtures of phosphates, silica, and coke are heated at high temperatures and the phosphoric acid distilled off and collected. At present rock phosphate, which is a mineral deposit of phosphate of lime, is employed almost exclusively for the preparation of superphosphate. The term acid phosphate is applied more particularly to the product obtained in this manner, although it is synonymous with superphosphate.

The lime and phosphoric acid content of mineral deposits of rock phosphate are combined in the proportion of three parts of calcium to two parts of phosphoric acid. When the rock phosphate is treated with sulfuric acid, the phosphorus is changed to a soluble form containing one part of calcium to two parts of phosphoric acid. Hydrated sulfate of lime is also formed during the chemical changes that occur. The superphosphate or acid phosphate thus prepared is almost entirely soluble in water and its phosphoric acid is therefore in an available condition. The hydrated calcium sulfate (gypsum or land-plaster) that is formed with the superphosphate should not be considered inert material; recent investigations show that sulfur is a very essential plant food, especially for the legumes. A high-grade superphosphate or acid phosphate should contain at least 16 percent of soluble, or available, phosphoric acid, and there will be mixed with this about 60 percent of gypsum.

Bone-meal. Bone-meal contains besides the organic nitrogen mentioned above about 25 percent of phosphoric acid. Most of this phosphoric acid is combined in a manner similar to the mineral rock phosphate, but is considered more available owing to the organic matter that is also present. The presence of the organic or animal matter facilitates decomposition, and the phosphoric acid becomes rapidly available for the plants.

Tankage and Fish-meal. In general both tankage and fish-meal are similar to bone-meal except that they contain only approximately one-half as much phosphoric acid. The availability is similar to the phosphoric acid in bone-meal.

MATERIALS THAT SHOULD NOT BE A PART OF MIXED FERTILIZERS

Ground limestone, hydrated lime, burned lime, gypsum or land-plaster, and ground raw rock phosphate should not be used in mixed fertilizers. All of these materials have their places either as soil amendments or as fertilizers, as the case may be, and can be used advantageously at times, but their cost is so much lower than the simples from which the mixed fertilizers are made that when they are added as a component part they should be classed as "filler" to make weight. It is of course understood that the gypsum naturally present in superphosphate will necessarily be present in a mixed fertilizer when superphosphate is a component part of that fertilizer.

The State Fertilizer Law does not require manufacturers to declare on the label or tag the various materials from which mixed fertilizers are compounded, but it does require them to file a statement with the chemist of the Oregon Agricultural Experiment Station showing of what these materials consist. Any person interested may obtain full information regarding the exact material used in a specific mixed fertilizer by writing to the Agricultural Chemistry department, Oregon Agricultural Experiment Station. Consumers should insist on being shown the official label at the time of contract and should understand fully the statements regarding the quality of fertilizers purchased. If there is any doubt regarding the quality of the fertilizer as indicated by the statement on the label, explanations may be obtained by writing to the chemist.

THE RELATIVE COMMERCIAL VALUE PER TON

As previously stated, the commercial value of fertilizers is entirely distinct from the agricultural value; the two have no true relation whatever, and farmers should be warned against judging the producing power of a fertilizer by its selling price.

During the past two years the number of dealers offering fertilizers for sale has increased greatly, and there are now on the market several very low grade brands which, although sold in accordance with the provisions of the fertilizer law, do not contain enough available plant food to warrant applying them to the soil. To avoid the purchase of practically worthless fertilizers and low grade material it is important to understand the meaning of the chemical analyses that must, according to the law, be declared on a tag or label attached to each sack.

Consumers of commercial fertilizers may avoid payment of inflated prices or excessive overhead charges by calculating for themselves the approximate commercial value of any brand on the market and comparing these prices with those of other brands produced by the same manufacturer or of brands of another manufacturer. The selling prices of commercial fertilizers are based upon the prevailing commercial values of the plant foods they contain. As fertilizers are sold on the basis of their plant-food content we may arrive at the commercial value of any

fertilizer by multiplying the number of pounds per ton of each plant food in the fertilizer by its value per pound and adding the products.

For convenience it is customary to speak of a "unit" of plant food, such as a unit of potash or a unit of nitrogen. This means 20 pounds or one percent of a ton (2000 lbs.). A unit of nitrogen per ton thus means 20 pounds of nitrogen per ton; for example, a fertilizer having 6 percent nitrogen contains 6 units of nitrogen in each ton. The actual cost per unit or per pound may be calculated easily in those fertilizers that contain only one plant food. For example, nitrate of soda contains 16 percent nitrogen or 16 units per ton. If the selling price is $66.00 per ton each unit would cost $4.12. The approximate price per unit and per pound of the various plant foods has been calculated from quotations of the fertilizer dealers of the state. These have been calculated from the lowest quotation on simples, or the basic fertilizer material from which mixed or complete fertilizers are prepared, and upon these prices the prices of the mixed fertilizer should depend. The price[1] per pound and per unit of plant foods, nitrogen, phosphoric acid, and potash in carload lots is as follows:

TABLE I. PRICES[1] OF PLANT FOODS PER POUND AND PER UNIT

	Price per pound	Price per unit
Nitrogen, N. available	$0.220	$4.40
Phosphoric acid, P_2O_5 available	.082	1.64
Phosphoric acid, P_2O_5 unavailable	.036	.72
Potash, K_2O available	.089	1.78

Since the foregoing figures show the actual cost per pound and per unit of plant food, we can calculate the number of pounds or units of plant food in a mixed fertilizer and estimate the actual cost per ton of that fertilizer. Take for instance a fertilizer composed of inorganic simples and guaranteed to contain the following plant foods:

Nitrogen, N. total	4%
Phosphoric acid, P_2O_5 available	10%
Phosphoric acid, P_2O_5 unavailable	2%
Potash, K_2O total	4%

Employing the data showing the price per pound and per unit given above we find:

POUND METHOD

$4 \times 20 = 80$,	number of pounds of N. in a ton.	$80 \times \$0.220 = \$17.60$
$10 \times 20 = 200$,	number of pounds of P_2O_5 in a ton.	$200 \times \$0.082 = 16.40$
$2 \times 20 = 40$,	number of pounds of P_2O_5 in a ton.	$40 \times \$0.036 = 1.44$
$4 \times 20 = 80$,	number of pounds of K_2O in a ton.	$80 \times \$0.130 = 7.12$
	Total cost or commercial value per ton	$42.56

UNIT METHOD

Nitrogen	$4 \times \$4.40 =$	$17.60
Phosphoric acid, available	$10 \times \$1.64 =$	16.40
Phosphoric acid, unavailable	$2 \times \$0.72 =$	1.44
Potash	$4 \times \$1.78 =$	7.12
Total cost or commercial value per ton		$42.56

A few words of explanation will make this clear. As given, a fertilizer that contains 4 percent nitrogen has the equivalent of 4 pounds per hundred, and as there are 2000 pounds in a ton, it would contain 20 times this amount, or 80 pounds. At $0.220 a pound this would cost $17.60. In like manner the cost of the phosphoric acid, available and

[1]Prices quoted September 1, 1922.

unavailable, and of the potash may be calculated. The sum of these values would therefore give the cost per ton of the fertilizer in question.

By using the unit system, the cost per ton may be more easily calculated. It is only necessary to multiply the price per unit by the percentage of plant food and then add the products as indicated above. This calculation will be more easily understood when we consider that the unit amount, 20 pounds, is 1/100 of a ton, and that the percentage of plant food represents units per ton so that it is only necessary to multiply the percentage of plant food in a fertilizer by the price per unit, quoted in Table I, to obtain the value of that fertilizer per ton. The sum total, therefore, of the cost of different plant foods contained in the mixed fertilizer gives the price of the fertilizer.

The commercial value obtained in the manner outlined above is not the actual selling price, but the approximate cost of the simples contained in mixed fertilizers. It will be understood that the manufacturer must charge an excess which is about $12.00 per ton to cover the cost of mixing the fertilizer, handling, agents, and other overhead charges. Consequently, a fair price for a mixed commercial fertilizer should be not more than $12.00 above the amount found by calculation. In other words, the fertilizer exemplified above should cost not more than $42.56 plus $12.00, or $54.56 a ton at the manufacturing plant in car-load lots.

If the farmer will make comparison of different brands of fertilizers, in the manner suggested above, it will enable him to obtain the best product at the lowest prices. If he has time to spare, it would be even more profitable to purchase the necessary simples and prepare his own mixed fertilizers. For instance, if he desires to fertilize a piece of land with nitrogen and phosphoric acid but not with potash, it will be necessary then to purchase only those materials or simples containing the plant foods desired; namely, superphosphate (for phosphoric acid) and nitrate of soda (for nitrogen), or if an organic combination is more suitable for the particular soil to be fertilized, he may purchase bone-meal (for nitrogen and phosphoric acid) and blood-meal (for nitrogen) to supply the necessary plant foods. Any other combination containing one or all of the important plant foods may be selected from the table showing the chemical composition of commercial fertilizers. This procedure and the advantages derived therefrom will be more fully appreciated when the calculations are made of the actual cost of the fertilizer ingredients and the quoted selling price of mixed fertilizers.

GRADES OF MIXED COMMERCIAL FERTILIZERS

If it is found advantageous to invest in a mixed or complete fertilizer, the highest grade materials should be purchased. It must be remembered that most low grade fertilizers contain sand or other inert filler upon which freight must be paid and time wasted in hauling from depot and applying to the soil. It is somewhat difficult to make an exact statement regarding a satisfactory division between high, medium, and low grade products. In general, however, it is understood that a brand containing a sum total of available nitrogen, phosphoric acid, and potash of 15 percent or above may be considered high grade; if between 12 percent and 15 percent it may be considered medium grade; and if under 12 percent it is low grade and should not be purchased, since it contains

too high a percentage of inert filler. As an example, the following fertilizer may be classified as high grade:

Nitrogen, total	4%
Phosphoric acid, available	10%
Potash, total	4%
	18%

Adding the percentages of plant-food content gives a total of 18 percent, indicating a high-grade fertilizer. On the other hand, the following example shows a total of only 11 percent plant-food content, which may be considered low grade:

Nitrogen, total	2%
Phosphoric acid, available	7%
Potash	2%
	11%

Very often all grades of fertilizers are carried by manufacturers and the prices for the lower and the medium grades appear cheaper, but if their cost is estimated as suggested above it will be found that the cost for each pound or unit of plant food is higher than in the high grade fertilizer. The agent or manufacturer may offer for sale both high and low grade fertilizers on the assumption that many buyers are attracted by and will purchase the apparently cheaper stuff. The price, however, is in part paid for inert filler. Furthermore, the charge of about $12.00 mentioned above for overhead and other expenses is equal for low and high grades. Since this overhead cost is proportioned on the basis of the plant foods contained in a fertilizer, we can readily see that it costs more per unit of plant food to place on the market a low-grade than a high-grade fertilizer. For example, a low grade fertilizer containing only 10 units of plant food would cost $1.20 for each unit, while a high grade fertilizer of 16 units would cost only $0.75 per unit. Furthermore, it is conceded by manufacturers that the purchase of high-grade fertilizers saves ⅜ or more on freight cost; that is, freight is charged on five tons for high grade instead of eight tons when the fertilizer is low grade. The additional tonnage is inert filler used in the low grade material. Likewise, it means five trips to the warehouse for a high grade fertilizer and eight trips for a low grade to obtain equal amounts of plant-food content; also only five bags are necessary for the high grade while eight are necessary for the low grade type. Thus the actual cost per unit of active ingredients of a mixed low grade fertilizer is probably almost double the cost of the high grade product.

RESULTS OF CHEMICAL ANALYSES

The table on pages 12 to 14 gives detailed results of the chemical analyses of all brands of fertilizers sold in Oregon during the season 1921-22. Information regarding analyses of fertilizers collected during 1919-1920 may be obtained by writing to Agricultural Chemistry, Oregon Experiment Station. The different columns show the guaranteed amount of total nitrogen and nitrate nitrogen, the total phosphoric acid and the parts thereof that are available and unavailable, and the total potash. In the columns following the amounts guaranteed by the manufacturer, are given the chemical analyses made by the Agricultural Chemistry department of the Oregon Agricultural Experiment Station of samples collected from different sources. The arrangement facilitates comparison of the guaranteed amount and the actual percentage of ingredients found by analysis.

TABLE II. GUARANTEED AND FOUND COMPOSITION OF FERTILIZERS SOLD IN OREGON

Name or brand	Manufacturer	Address	Nitrogen				Phosphoric Acid						Potash	
			Total N.		Nitrates		Total P_2O_5		Ave. P_2O_5		Ins. P_2O_5		K_2O	
			Guaranteed	Found	Guaranteed	Found	Guaranteed	Found	Guaranteed	Found	Guaranteed	Found	Guaranteed	Found
			%	%	%	%	%	%	%	%	%	%	%	%
Red Steer A. Special	Swift & Co.	Portland, Oregon	3.3	3.9	2.0	2.2	11.9	11.8	10.0	9.6	1.9	2.2	2.0	2.5
Red Steer B.	Swift & Co.	Portland, Oregon	1.6	3.1	1.0		13.2	13.6	12.0	11.3	1.2	2.3	3.0	3.4
Red Steer C.	Swift & Co.	Portland, Oregon	2.5	2.5	1.5	1.6	11.5	13.2	10.0	10.8	1.5	2.4	4.0	3.8
Red Steer D.	Swift & Co.	Portland, Oregon	3.3	4.6	2.0	3.1	8.7	10.2	7.0	7.2	1.7	3.0	6.0	6.4
Red Steer E.	Swift & Co.	Portland, Oregon	2.5	2.5	1.5	.....	11.5	11.3	10.0	10.1	1.5	1.2	10.0	10.5
Red Steer M. Special	Swift & Co.	Portland, Oregon	2.5	2.4	1.5	.....	13.6	13.3	12.0	11.8	1.6	1.5	1.0	1.6
Red Steer O.	Swift & Co.	Portland, Oregon	2.1	4.2	1.3	2.4	10.3	11.2	9.0	9.7	1.3	1.5	2.3	4.0
Red Steer orchard dressing	Swift & Co.	Portland, Oregon	10.7	12.2	10.1	11.2	9.0	7.6	4.5	3.8	4.5	3.8	.....	.....
Red Steer hop fertilizer	Swift & Co.	Portland, Oregon	6.6	5.6	5.8	.....	14.1	15.6	5.1	8.5	9.0	7.1	.....	.....
Red Steer hop dressing	Swift & Co.	Portland, Oregon	9.0	9.2	0.9	1.0	14.9	17.9	9.0	10.5	5.9	7.4	.....	.....
Red Steer Special 2-14-1	Swift & Co.	Portland, Oregon	1.6	1.3	1.0	.....	15.3	15.4	14.0	14.3	1.3	1.1	1.0	4.8
Red Steer 6-7-8	Swift & Co.	Portland, Oregon	4.9	4.5	2.7	.....	9.4	8.5	7.0	.....	2.4	.....	8.0	8.4
Red Steer roselawn	Swift & Co.	Portland, Oregon	4.9	4.6	.....	.....	21.0	24.1	10.5	12.1	10.5	12.0	.....	.....
Red Steer nitrate of soda	Swift & Co.	Portland, Oregon	15.0	15.2	15.0	15.2	.....	.....	.....	.....	.....	.....	.....	.....
Red Steer sulfate of ammonia	Swift & Co.	Portland, Oregon	20.6	19.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Red Steer blood meal	Swift & Co.	Portland, Oregon	13.2	11.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Red Steer No. 1 tankage	Swift & Co.	Portland, Oregon	7.4	6.8	.....	.....	10.0	14.0	5.0	7.0	5.0	7.0	.....	.....
Red Steer No. 5 tankage	Swift & Co.	Portland, Oregon	4.1	3.7	.....	.....	16.0	13.7	8.0	6.9	8.0	6.9	.....	.....
Red Steer bone meal	Swift & Co.	Portland, Oregon	2.3	3.3	.....	.....	24.0	23.9	12.0	12.0	12.0	11.9	.....	.....

Red Steer fish guano	Swift & Co.	Portland, Oregon	8.2	8.5	.....	.....	10.0	8.2	5.0	4.1	5.0	4.1	.....	.....
Red Steer acid phosphate	Swift & Co.	Portland, Oregon	.....	.....	.....	.....	18.3	17.8	17.5	16.3	.8	1.5	.....	.....
Red Steer muriate of potash	Swift & Co.	Portland, Oregon	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56.0	57.2
Lawn and rose fertilizer	Portland Seed Co.	Portland, Oregon	2.51	2.6	.....	.....	7.5	5.7	4.5	4.3	3.0	1.4	.....	.....
Fruit and onion fertilizer	Portland Seed Co.	Portland, Oregon	1.7	2.1	.....	.....	9.3	14.1	5.8	8.5	3.5	5.6	2.8	3.2
General or vegetable fertilizer	Portland Seed Co.	Portland, Oregon	3.3	2.3	.....	.....	10.6	10.7	4.7	6.2	5.9	4.5	1.1	1.0
Diamond plant food	Portland Seed Co.	Portland, Oregon	5.3	.....	.....	.....	8.5	.....	8.0	.....	.5	.....	10.0	.....
Nitrate of soda	Portland Seed Co.	Portland, Oregon	15.0	15.1	15.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Superphosphate	Portland Seed Co.	Portland, Oregon	.....	.....	.....	.....	17.6	18.4	17.6	17.9	.....	.....	.....	.....
Muriate of potash	Portland Seed Co.	Portland, Oregon	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50.5	52.5
Bone meal	Portland Seed Co.	Portland, Oregon	4.0	3.1	.....	.....	20.0	23.9	10.0	11.9	10.0	12.0	.....	.....
Sheep guano	Portland Seed Co.	Portland, Oregon	1.3	1.4	.....	.....	1.4	2.2	.....	.....	.....	.....	.....	.....
"Pep" fertilizer	Marine Products Co.	Tacoma, Wash.	6.0	.....	.....	.....	10.0	.....	.....	.....	.....	.....	4.0	.....
Harris special fertilizer	Marine Products Co.	Tacoma, Wash.	1.0	1.2	.....	.....	8.0	9.1	5.0	.....	3.0	.....	10.0	8.6
Clark's Wenatchee orchard dressing	Marine Products Co.	Tacoma, Wash.	6.0	.....	.....	.....	10.0	.....	5.0	.....	5.0	.....	4.0	.....
Puyallup brand special berry fertilizer	Marine Products Co.	Tacoma, Wash.	2.0	1.9	.....	.....	10.0	12.1	5.0	4.9	5.0	7.2	2.0	2.5
Dry cow manure	Pacific Products Co.	Portland, Oregon	1.4	1.5	.....	.....	.....	.....	0.6	1.7	.....	.....	1.7	2.1
Sheep guano	Pacific Products Co.	Portland, Oregon	1.5	1.9	.....	.....	1.1	2.1	0.7	1.1	0.4	1.0	1.9	2.2
Bone meal	Pacific Products Co.	Portland, Oregon	3.9	3.5	.....	.....	22.9	21.6	7.7	10.8	15.2	10.8	.....	.....

TABLE II. GUARANTEED AND FOUND COMPOSITION OF FERTILIZERS SOLD IN OREGON—(*Continued*)

Name or brand	Manufacturer	Address	Nitrogen				Phosphoric Acid						Potash	
			Total N.		Nitrates		Total P_2O_5		Ave. P_2O_5		Ins. P_2O_5		K_2O	
			Guaranteed	Found	Guaranteed	Found	Guaranteed	Found	Guaranteed	Found	Guaranteed	Found	Guaranteed	Found
Gromore No. 1	The Pacific Guano and Fertilizer Co.	San Francisco, Cal.	6.0	6.2	6.0	6.2	9.0	12.5	8.0	8.4	1.0	4.1	5.0	5.0
Gromore No. 2	The Pacific Guano and Fertilizer Co.	San Francisco, Cal.	3.0	3.1	3.0	3.1	8.0	8.6	7.0	7.6	.....	.....	2.5	1.9
Gaviota Superphosphate	The Pacific Guano and Fertilizer Co.	San Francisco, Cal.	.....	.....	.....	.....	18.5	18.4	17.5	17.9	1.0	0.5	.....	.....
Wonder	Western Fertilizer Company	San Francisco, Cal.	6.0	5.1	6.0	5.1	9.0	10.7	9.0	0.0	.....	.....	5.0	5.4
Wizard	Western Fertilizer Company	San Francisco, Cal.	6.0	4.1	6.0	4.1	9.0	10.9	9.0	0.8	.....	.....	5.0	5.5
Sheep guano	Adams Bros. Packing Co.	Portland, Oregon	2.0	1.5	.....	.....	1.5	1.1	.....	.....	.....	.....	2.0	0.9
Soda nitrogen	American Nitrogen Products Co.	Seattle, Wash.	18.0	17.8	9.0	4.8	13.0	percent nitrite nitrogen.						
Nitrate of soda	Balfour Guthrie & Co.	Portland, Oregon	14.0	15.5	14.0	15.5	.....	.....	.....	.....	.....	.....	.....	.....
Bone meal	D. L. Blodgett Co.	Portland, Oregon	.....	3.7	.....	.....	29.6	.....	.....	.....	.....	.....	.....	.....
Sheep manure	Clifford H. Brown	Salem, Oregon	2.0	1.6	.....	.....	1.5	1.8	1.5	.....	.....	.....	2.0	1.8
More crop	Chas. H. Lilly Co.	Portland, Oregon	2.0	2.0	.....	.....	10.0	15.4	.....	.....	.....	.....	2.0	1.9
Stim-U-Plant	Earp-Thomas-Cultures Corporation	New York, N. Y.	11.0	10.9	11.0	10.9	12.0	11.2	11.6	11.2	.4	.....	12.0	13.3
Mococo superphosphate	Mountain Copper Co.	San Francisco, Cal.	.....	.....	.....	.....	18.0	18.1	17.5	18.1	.5	.....	.....	.....
Bone meal	Oregon Bone Works	Portland, Oregon	3.0	4.4	20.0	23.2	10.0	11.6	10.0	11.6	.....	.....	.....	.....
Groz-et sheep manure	Pacific Manure and Fertilizer Co.	San Francisco, Cal.	1.7	1.3	1.0	.....	1.0	2.5	.....	.....	.....	.....	3.0	2.5
Bigger crop fertilizer	Pac. Ore. Reduction and Chemical Corporation	Grants Pass, Oregon	9.0	0.9	5.0	0.4	.....	.....	.....	.....	.....	.....	5.0	0.9
Twin buck sheep manure	S. Blachley Fert. Co.	Starbuck, Wash.	2.0	1.3	.....	.....	1.3	2.1	.....	.....	.....	.....	1.9	0.9
Vallepak tankage	Valley Packing Co.	Salem, Oregon	5.7	5.0	.....	.....	11.4	17.6	11.4	8.9	.....	.....	.....	.....
"Toro" sulfur	San Francisco Sulfur Co.	San Francisco, Cal.	.....	.....	.....	.....	Elemental sulfur 80.0%							
							Combined sulfur 3.0%							

In order to ascertain whether a certain brand is high, medium, or low grade, add the percent indicated in those columns marked "Total nitrogen," "Total phosphoric acid," and "Total potash." To calculate their comparative commercial value, multiply the various percents given by the unit value previously cited, and the sum total of the products will indicate the approximate cost.

GYPSUM OR LAND-PLASTER

Gypsum or land-plaster is sulfate of lime containing water of combination, represented chemically by the formula $CaSO_4.2H_2O$. This material should not be used in mixed fertilizers, although in the light of recent investigations the value of sulfur in the sulfate form as a plant food and fertilizer is more generally recognized. The use of land-plaster in various parts of Oregon has been found very profitable, and noteworthy increases in crop production have been obtained, especially with the legumes. If it is found desirable and profitable to use gypsum, it may be purchased in a comparatively pure form at a very reasonable price.

A separate law has been recently enacted by the state legislature to regulate the sale of agricultural lime, which includes gypsum. This is called the State Agricultural Lime Law. Agricultural lime referred to in this manner includes gypsum or land-plaster and ground limestone and hydrated lime. Most of the ground limestone supplied to the farmers throughout the state is obtained from the State Lime Plant at Gold Hill, Oregon, although five other licensed brands have been offered for sale during the past year. There are on the market several brands of gypsum or land-plaster, and for the benefit of those interested in this material a table is given indicating the various brands sold in Oregon, together with the average chemical analysis of numerous samples collected from different sources during the past year.

The table shows the actual amount of gypsum, $CaSO_4.2H_2O$, guaranteed by the manufacturer and found by official analysis, in each sample. One column shows the amount of insoluble or inert material, composed of silica, iron, aluminum, calcium, and magnesium compounds, none of which should be considered desirable for the purpose for which the gypsum is purchased.

TABLE III. GUARANTEED AND FOUND COMPOSITION OF DIFFERENT BRANDS OF LAND-PLASTER SOLD IN THE STATE

Brand	Manufacturer	Address	$CaSO_4.2H_2O$ Guaranteed	$CaSO_4.2H_2O$ Found	Inert material Found
			%	%	%
Alabastite	Jumbo Plaster and Cement Co.	Sigurd, Utah	99.4	97.6	2.4
Apex	Acme Cement Plaster Co.	Portland, Oregon	79.8	83.1	16.9
Empire	Pacific Portland Cement Co.	San Francisco, Calif.	90.0	95.2	4.8
Nephi	Nephi Plaster and Mfg. Co.	Salt Lake City, Utah	91.9	92.8	7.2
Toro Sulfur	San Francisco Sulfur Co.	San Francisco, Calif.			
				(Elemental sulfur	80.0%
				(Combined sulfur	3.0%

From Table III it will be observed that there is a wide variation in the calcium-sulfate content of the various brands of gypsum sold in Oregon. All brands will probably be equally efficient provided equal

amounts of $CaSO_4.2H_2O$ are applied to the soil. This means that a brand containing 90 percent gypsum must be applied in larger quantities proportionately than the brands containing 98 percent gypsum. Consequently, since $CaSO_4.2H_2O$ is the active ingredient, the selling price should be in proportion to the amount of that compound present. Thus a brand containing only 80 percent $CaSO_4.2H_2O$ should be proportionally cheaper than a brand containing 90 percent $CaSO_4.2H_2O$. In other words, if the 90 percent product costs $9.00 a ton the 80 percent material should cost only $8.00 a ton. The materials of which the inert matter is composed should not be considered of any value from a land-plaster standpoint. On the other hand, they are harmless.

LIMESTONE AND HYDRATED LIME

The use of limestone and hydrated lime for correcting soil acidity is quite generally known. Most of the soils of Western Oregon are more or less acid, and applications of limestone may be advantageously made. It has been found that some soils, although distinctly acid according to results obtained by our laboratory methods, do not respond to lime treatment. The Oregon Agricultural Experiment Station is now investigating this phase of the subject in order to ascertain the causes of the abnormal condition. Any soil that responds to lime treatment, however, should receive applications of limestone or hydrated lime once in three or four years.

During the past year four firms have taken out a license to sell either limestone or hydrated lime. The names of the manufacturer and the guaranteed and found composition of their products are given in Table IV.

TABLE IV. GUARANTEED AND FOUND COMPOSITION OF DIFFERENT BRANDS OF LIME SOLD IN THE STATE

Brand	Manufacturer	Address	Calcium carbonate		Calcium hydrate		Neutralizing value as $CaCO_3$
			Guar.	Found	Guar.	Found	
			%	%	%	%	
Puritan Lime	General Basic Products Co.	Seattle, Wash.			92.8	91.6	118.0
Fertilime	International Lime Co.	Sumas, Wash.	3.2	0.9	86.9	82.5	110.0
H. O. Lime	Orcas Lime Co.	Seattle, Wash.	39.0	57.0	48.0	14.0	105.0
Ground Lime Stone	Orcas Lime Co.	Seattle, Wash.	96.4	94.0			97.0
Ground Lime Rock	Western Products Co.	Tacoma, Wash.	94.0	94.4			94.0
Limestone	State Lime Plant	Gold Hill, Ore.	86.0	86.0			86.0

From the foregoing analyses the comparative commercial value and quality of the different brands may be seen. The last column gives the neutralizing value calculated from the analyses and expressed in terms of calcium carbonate. The quality and its value for correcting soil acidity or sourness is proportional to the neutralizing values stated. The cost of these different brands should therefore be in proportion to their neutralizing value.